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Strategy for Development of Geothermal Resources in India

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ABSTRACT

The geothermal resources are widely spread in India along the Himalayan Belt, west coast of India, Narmada Tapi lineament and the Godavari valley. A total of 340 hot springs are reported in India, ranging in temperature from 32°C to 97°C at the surface. The Geological Survey of India has carried out investigations for proving resource potential of some promising fields like Puga in Jammu & Kashmir, Tatapani in Chhattisgarh state, Tapoban and Manikaran in Himachal Pradesh, and hot springs of west coast of India. Geological mapping, geophysical survey, and drilling at shallow level were completed in these geothermal areas. In spite of completing the exploration in these areas, not much work could be done for the development of geothermal resources. The geothermal resources are useful in providing energy in remote areas and as a substitute to the fossil fuels. Considering the need to develop environmental friendly energy resources, it is proposed to prepare a strategy for development of geothermal resources in India.

The main constraint in development of geothermal resources in India is lack of facility for deeper level > 2000m depth, exploration by drilling, and involvement of private entrepreneur as end user of the geothermal energy. It is proposed to have a systematic plan involving geological investigation to identify anomalous energy resource zones to prioritize further exploration programme, involving technical expertise from India and abroad; offering incentives to geothermal energy development at par with the other non- conventional energy resources like solar and wind energy. It is also suggested to encourage private – public partnership with incentives for attracting foreign direct investment (FDI), with duty concessions for import of machinery required for geothermal exploration and power generation. Technical collaboration with the leading international agencies, with a scope for technology transfer may be encouraged. Geothermal exploration requires heavy investment at the initial stages. Finance may be made available on easy long-term soft loans at concessional rates. Besides, as the cost of electricity generated by a geothermal source is high initially, suitable subsidy may be provided for encouraging development of geothermal resources in India.

1.0 INTRODUCTION

Geothermal resources are distributed all over India in form of hot springs with temperature ranging from 32°C to 97°C. A total of 340 hot springs are reported in India, most of which are located along the Himalayan foothills, west coast of India and along Son-Narmada lineament in central India. The Geological Survey of India carried out investigation by drilling in Puga Valley, Ladakh, Manikaran, Tapoban etc fields at the Himalayan foothills (Krishnaswamy 1982); Tatapani in Chhattisgarh (Pitale et al, 1995; Sarolkar and Mulhopadhyay 1994) and the west coast area (Pitale and Padhi 1995); proving low to intermediate temperature resources. Despite the constant demand for energy, the geothermal resources are yet not explored properly nor is there any development of a resource for electricity generation. The present work proposes the measures for fast track development of geothermal resources in India.

2. GEOTHERMAL PROSPECTS IN INDIA

The salient features of the important geothermal prospects in India (Pitale and Padhi 1995) are described to facilitate understanding of possible utilisation schemes.

2.1 Puga-Chhumathang Geothermal Field, Ladakh

The hot springs average temperatures are 84°C in Puga and 87°C at Chhumathang. Maximum discharge from a single spring is 15 litres/s. Borehole temperature is 125°C (GSI, 1991). Estimated reservoir temperature is 180° to 260°C. Deposition of sulphur and borax is observed around the springs.

2.2 Manikaran, Himachal Pradesh State

Maximum temperature of 96°C is recorded in springs at Manikaran, located in Himachal Pradesh. The boreholes drilled at Manikaran yield hot water of 86°C to 94°C. Maximum temperature recorded in a borehole is 101°C. The estimated reservoir temperature ranges from 186° to 202°C.

2.3 Parbati Valley, Himachal Pradesh State

Thermal anomaly extends over a distance of 70 km manifested by hot springs of 30°C to 57°C. Drill holes show artesian flow. Maximum discharge of hot water is 350 litres /m of 67°C. The estimated reservoir temperature is 140° ± 20°C.

2.4 Tapoban area, Uttarakhand State

This geothermal prospect covers the Joshimath, Chamoli and the other hot springs on the banks of Dhouli Ganga river with temperatures of 65°C and discharge of hot water at 0.83 to 9.22 litres/sec. A borehole at a depth of 79 m depth shows a temperature of 80°C and a flow of 11 litres/sec. Estimated reservoir temperature is 180°C ± 20°C.

2.5 Tatapani Geothermal Field, Chhattisgarh State

A number of hot springs are located along the Son-Narmada lineament, with temperatures of 52°C to 97°C at the surface. Hot water discharge of five production wells with maximum depth of 350 m measured 30 litre/sec. The indicated reservoir temperature is 160°C to 190°C.

2.6 Anhoni Samoni, Madhya Pradesh State

Hot springs with temperatures of 30°C to 42°C are reported from this area. A borehole drilled to a depth of 262 m yielded free flowing water of 54°C and profuse gas emission with methane ≈80% (Pitale, 1993). The reported thermal gradient is 58°C/km.

2.7 West Coast Thermal Springs, Maharashtra State

Thermal springs show temperatures of 34°C to 71°C, from Koknere in the north to Rajapur in the south. Thermal gradient varies from 36°C to 78°C/km. Indicated reservoir temperature is 110° ± 10°C.

2.8 Cambay Basin, Gujarat State

Boreholes drilled for oil exploration has encountered high thermal anomaly zones. A thermal gradient of 70°C/km is reported and a heat flow of 83mW/m2 was reported in the boreholes (Gupta, 1981).

2.9 Sohna, Haryana State

The hot springs are located near Sohna town in an alluvial tract. Thermal springs records show a temperature of 46°C. The boreholes drilled have yielded hot water of 44°C to 55°C and discharge of 0.5 to 6 litres/sec.

2.10 East and North East Region

Isolated hot springs are reported at Surajkund, Bihar (88°C), having indicated reservoir temperature of 110°C. Hot spring discharge is 4 litre/sec.

2.11 Salbardi, Amaravati District and Unkeshwar, Nanded District

Hot water at 38 to 42°C temperature is discharged at Salbardi, located 70 km from Amaravati district. Indicated reservoir temperature is 110 ± 10°C. Hot springs discharging water of 40°C to 44°C at 37 to 51 litres/m are reported near Unkeshwar Temple. A hand pump in Kambala village also yields hot water of 36°C. Indicated reservoir temperature ranges from 86°C to 120°C.

3.0 MAJOR ISSUES FOR DEVELOPMENT OF GEOTHERMAL RESOURCES IN INDIA.

Energy plays an important role in achieving social, economic and environment goals for sustainable development. In most countries including Indonesia, the domestic energy demand is met mostly by fossil energy sources, particularly by oil, while oil reserves are limited (Suryantoro et al 2005). Also, in India the need to meet increasing energy demand necessitates development of alternate renewable source of energy including geothermal. Besides, the pressure to reduce greenhouse gas emission along with the need to produce sustainable energy necessitates development of renewable energy sources including geothermal. Geothermal energy is site specific hence, useful to cater to the demand of remote localities where it is very expensive and sometimes impracticable to supply the power generated from fossil fuels.

In India, the geothermal development is still lagging behind as the coal resources are plenty and easily exploitable. Besides, the cost of geothermal exploration is very high as compared to coal, causing concern among the investors.

The major constraints in development of geothermal energy in India are:

a) There is less awareness about geothermal energy sources; hence, entrepreneurs are not attracted.

b) The geothermal resources are located in remote areas; hence, cost of development is higher as compared to the cost of development and production of fossil fuels.

c) The initial cost of exploration is very high as compared to the exploration of coal resources, while the actual resource potential is yet to be established.

d) The equipment and machinery required for geothermal exploration and development is not available in the domestic market.

e) The government policy to encourage the geothermal exploration to offset the high cost of exploration and risk involved is still in process.

Considering the above constraints, it is proposed to adopt the following measures for development of geothermal resources in India.

3.1 GOVERNMENT POLICY

Geothermal resources are mainly heat content in the sub-surface rocks and water. In India, the ground water is state subject and is the property of the State Government; while the surface mineral resources are property of the individual. The geothermal resources are deeply seated, controlled by the hydrological system which is separate from shallow ground water sources. Besides, the need to exploit the geothermal resources judiciously, for sustainable development, require that the geothermal energy sources may be declared as “national energy sources”, controlled by common policy issued by the Central Government.

The present data on geothermal prospects needs to be updated. It will be appropriate to provide the geological data up to the depth of 500 m to the entrepreneurs. A basic database comprising geology, geochemistry, geophysical surveys and geothermal parameters may be prepared for all selected fields suitable for development. If necessary, drilling up to the depth 500 m may be carried out in selected blocks suitable for power generation or direct heat uses.

3.2 Public Relations

There is a need to create awareness among the public about the use of geothermal energy as a substitute to fossil fuels. Public relations should bring the advantages of geothermal energy across to the public not just with technical facts but also with appealing images highlighting the benefits of geothermal energy in electricity generation (Sanner and Bussmann, 2005) and ancillary uses like space heating, cold storages, and aquaculture. This can be done by issue of newspaper articles, video documentary and brochures. This was demonstrate by a comprehensive review of geothermal stamps by Lund 2003 (Sanner and Bussmann, 2005).

3.3 Installing Demonstration Geothermal Power Plant

Geothermal energy technology is still new in India. There is a need to demonstrate the feasibility of geothermal energy as a substitute to fossil fuels and the benefits of geothermal energy in controlling pollution to generate confidence to the public for use of the geothermal energy. In Germany, the first geothermal plant for electric power generation in Germany has been working since November 2003 at the North German Basin at Neustadt-Glewe, from a low enthalpy resource, to promote use of geothermal energy (Kranz, 2003).

3.4 Geothermal Prospecting Policy

Geothermal fluids constitute a resource situated in the deep underground. The ground water development and utilization is controlled by ground water exploitation guidelines set out by the central and state governments. Considering these aspects, to have sustainable use of geothermal resources, these prospects may be declared as property of the Government of India, as is the case with hydrocarbons. This will help in systematic development and management of deep geothermal resources. State guidelines may however be followed for providing relevant approvals / licenses for exploration and mining.

The development of geothermal energy is more akin to oil exploration and development; hence the policy guidelines may be similar to exploration of petroleum and natural gas, hence, the licensing, monitoring of exploration activity and development plans should be controlled by a Central Agency, preferably the Ministry of New and Renewable Energy (MNRE), to expedite development of geothermal prospects. The reconnaissance permit and prospecting lease may be issued by the MNRE in assistance from the State Government, over the areas selected by MNRE as blocks suitable for development.

Cost of drilling geothermal boreholes is very high as the depths of boreholes are in the range of 2-3 km. Moreover, the deep drilling for geothermal exploration is similar to oil exploration, and an integrated multi-utility drilling has to be employed to cut down the costs. Hence, detailed drilling with more exploratory boreholes per sq km may be allowed in case of geothermal exploration. The developer shall have the responsibility to maintain the sustainability of production from the reservoir and avoid over-exploitation of the reservoir by adopting appropriate reservoir management techniques. There is need to declare a Central Legislation for appropriate reservoir management techniques.

3.5 Incentives for Investment

The renewable energy schemes have higher production costs than fossil fuels but they are sustainable. Therefore, the government should put some funds for adjustment (initial) costs to encourage the development of renewable energy resources including geothermal and technologies in view of its environmental and social objectives. The remarkable amount of utilization of hydro geothermal heat for district heating in France was made possible by a programme for tax incentives in the late 80’s and since then not many new installations have been realized in spite of favourable operational cost (Sanner and Bussmann, 2005).

3.6 Infrastructure Facility

The geothermal resources are mostly located in the interior parts, away from the mainland. Considering the high cost of geothermal exploration, the entrepreneurs need support in the form of infrastructure development. The local government should provide logistic support by construction of roads, rehabilitation of population, small scale industry zones and tourist parks etc.

3.7 Transmission and Distribution

Transmission of the generated electricity to the nearest grid should be done by the producer. The power shall be transmitted to the nearest grid point/local distribution point as per the agreement with the State Electricity Board. Electricity Boards may purchase power from the producer as per MNRE guidelines for renewable energy sources. Minimum 25% of the power generated should be sold to the State Electricity Board. The producer should be at liberty to sell the rest of the power to any suitable customer at prevalent rates, recommended by the competent authority.

3.8 Byproduct Utilization

The direct heat utilization of geothermal water can be also planned for the effluent water from the geothermal power plant having suitable heat content. It is therefore proposed that the MNRE should encourage suitable direct heat utilization at different geothermal areas. The direct heat utilization schemes may benefit the local population, and development of low temperature geothermal resources. This effort will also make the public aware about the role of geothermal energy in the development of the interior areas and societal benefits.

3.9 Public Private Partnership

Considering the large scale investment required for development of geothermal resources, partnership between the private, public and government sectors may be encouraged. The foreign direct investment may be encouraged for exploration and development of geothermal resources provided the “foreign collaboration” is tied up with technology transfer.

The private parties may be encouraged to take up geothermal exploration and development activity on BOT basis. The BOT allowed the entry of international power utilities to fund construct and operate geothermal power plants, thus increasing the much needed electrical generation without increasing our national debt (Butiu, 2005).

3.10 R & D Activity

Geothermal resource development is a dynamic activity, requiring constant monitoring of the discharge and quality of water to assess conditions to sustain the production and environmental impact. The conditions of steam/hot water supply, input parameters and effluent characters as well as turbine efficiency need to be upgraded to improve efficiency and economics of the production. Considering, these aspects, an amount of 10% of total turnover may be utilized for research and development exempted from the tax liabilities may be of the company/project. The R & D output of the Applicant / Agency will be reviewed after every 3 years to allow continuation of the benefit.

Establishing state-of-the-art laboratories for geochemical and geophysical analysis and modeling; modernization of equipment like EPMA, isotope studies, etc. are essential for planning development of geothermal resources. To facilitate the site-specific design of smaller plants, the Geological Survey of Nordrihein-Westfalen has compiled a database of ground thermal parameters down to 100 m depth for the whole area of the state, available on CD-ROM. Similar work is under way in other states also (Sanner and Bussmann, 2005).

3.11 Capacity building

The continuity of geothermal investigations in India needs technical manpower, for which special training programmes may be formulated. Regular training programmes for various aspects of geothermal exploration and power generation may be initiated. MNRE shall take the lead in the creation of the technical manpower by providing training facility in India and abroad. The institution like Geological Survey of India (GSI) and the National Geophysical Research Institute (NGRI) may be designated as the Nodal Agencies due to their proven expertise in the respective fields.

3.12 Environmental concessions

The entrepreneur has to follow forest and environmental laws applicable for exploration. All the projects for power generation need environmental clearance. Geothermal is a clean energy hence may be given exemption from environmental clearance. The clearance and EIA may be facilitated by the Ministry under a single window. The impact on physical features of the Earth’s surface, if any, due to exploration/drilling activity may be compensated by adopting suitable mitigation measures. In case of any disturbance of rights of the owner or occupier of any land, or nuisance or damage to land, crops, trees, buildings, stock or works in the course of exploration or development of geothermal resources, reasonable compensation has to be made by the licensee (Mwawughanga, 2005)

4.0 CONCLUSION

The geothermal development in India is poised to take a lead in the near future. It is essential to provide guidelines for exploration and development of geothermal resources, similar to oil and gas resources. The basic database on selected geothermal areas may be prepared for the benefit of entrepreneurs. The geothermal exploration may be expedited by providing financial incentives for power generation. Private and public partnership may be encouraged by simplifying official procedures and providing financial incentives for development of renewable energy.

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